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PATENT APPLICATION OF

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ENTITLED

SAMPLE HANDLING SYSTEM WITH SOLVENT WASHING

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SAMPLE HANDLING SYSTEM WITH SOLVENT WASHING

CROSS REFERENCE TO RELATED APPLICATIONS

This is a Continuation-In-Part Application of U.S. Patent Application Serial No. 10/358,100, filed February 4, 2003 entitled SAMPLE HANDLING SYSTEM WITH SOLVENT WASHING.

BACKGROUND OF THE INVENTION

Process analytic systems are used in a variety of industries to measure process characteristics in substantially real-time. Such industries include the chemical, petrochemical, pipeline, and pharmaceutical industries. Process analytic systems are often used for process gas analysis, combustion analysis and control, and emissions monitoring in any of the above industries.

Process analytic systems differ substantially from laboratory analyzers in the manner in which sample handling is effected. For example, samples are usually held as a gas or liquid in an appropriate container that is transported, sometimes by hand, to a laboratory analytical instrument. In contrast, the process analytic system receives its sample directly from a sampling point in the process, without human assistance. Process analytic systems can include a process analyzer and a process sample handling system.

For a process analyzer in a process analytic system, such as a process gas chromatograph, to provide an accurate analysis of the process, it is important to convey the sample from the process to the analyzer such that the sample is representative of the process. Since any number of variables can affect the extent to which the sample represents the process, it is desirable to control many variables including temperature, pressure and flow while conveying the sample to the analyzer. Further complicating matters is the fact that the sample may be quite hot and under considerable pressure, contain water vapor, solids, condensed liquid, acids and/or other substances, etc. One example of a known process analyzer is the Continuous Analyzer Transmitter, available from Rosemount Analytical, Inc., of Anaheim, California. Another example of a known process analyzer is the Model GCX Process Gas Chromatograph, available from Rosemount Analytical, Process Analytic Division, of Orrville, Ohio.

A process sample handling system is utilized in a process analytic system to extract a process sample from a sampling point and convey the sample to a process analyzer. Generally, the sample handling system includes all requisite components to maintain a constant sample flow to the analyzer. Thus, the sample handling system generally includes suitable pressure reduction components, filters, vaporizers, flow controls, and sample switching or

selector valves for introducing multiple sample streams or a calibration standard to the process analyzer. With the exception of vaporizers, filters, and pressure reducers, most components of the sample handling system are usually located near the process analyzer, and sometimes within the same housing as the analyzer. The process sample handling system is an important component of an effective process analytic system. If the process sample is not delivered to the process analyzer in a condition that is representative of the process, errors will occur in the analysis. Many of the problems encountered in process analytic systems can be traced to a problem occurring in the process sample handling system.

Many industrial samples encountered by the sample handling system contain a number of substances which are not of interest, but which nonetheless may not only adversely affect accuracy of the analysis, but also accelerate deterioration of the sample handling system and/or associated analyzer. Examples of such substances include hydrochloric acid (HCL), chlorine gas, sulfuric acid (H_2SO_4), as well as various solids. These substances not only reduce the quality of analysis, but also cause accelerated deterioration on the process analytic system itself. A system which could ameliorate the effects of such substances on both analyses and analytic system itself, would be highly beneficial to the act of process analysis.

SUMMARY OF THE INVENTION

A sample handling system includes a sample probe that is adapted to intermix a solvent with a sample obtained from a process to dissolve undesirable components within a sample. A separator is provided in the sample handling system that receives the solvent/sample mixture and separates the sample from the solvent and undesirable solutes. The so separated sample is then provided to a suitable analyzer for analysis.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a diagrammatic view of a process analytic system in accordance with an embodiment of the present invention.

Figs. 2 and 3 are diagrammatic views of a sample probe in accordance with embodiments of the present invention.

Fig. 4 is diagrammatic view of sample probe in a accordance with embodiments of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Fig. 1 is a diagrammatic view of a sample handling system for measuring carbon monoxide and oxygen in accordance with embodiment of the present invention. Although the system shown in Fig. 1 will be described with respect to a specific solvent

(water) and water-soluble substances, it is expressly contemplated that other solvent/solute combinations can be used in accordance with embodiments of the present invention.

System 100 includes enclosure 102, air inlet 104, sample probe 106, solvent inlet 108, drain 110, vent 112, zero gas inlet 114, span gas inlet 116 and 118, and vent 120. Sample probe 106 is generally disposed at or within a stack or process line and is adapted to receive a relatively small amount of sample from within the stack or process line. The sample is conveyed along line 124 into enclosure 102 and subsequently to four-way valve 126. Preferably, line 124 is sized to have an outer diameter ranging from approximately 9.53 millimeters to approximately 12.7 millimeters. Additionally, it is preferred that line 124 be constructed from a corrosion resistant tubing and physically adapted to slope from stack or duct 122 toward the inlet of mixer 128. Such sloping is illustrated diagrammatically by the diagonal line. In embodiments where sample handling system 100 will be exposed to subfreezing temperatures, line 124 can be provided with heating elements and insulation as desired. In Fig. 1, valve 126 is illustrated fluidically coupling sample probe 106 to mixer 128 (also referred to herein as jet pump 128). An alternate port coupling of valve 126 is shown with dashed lines wherein, upon actuation, dry instrument air is coupled to sample probe 106 to essentially

provide a blow-back function. The blow-back airflow is determined in part by pressure regulator 130. Pressure indicator 132 indicates the blow-back pressure as set by pressure regulator 130.

The pressure within sample line 124 downstream from valve 126 is indicated by pressure indicator 134. Sample is provided to jet pump 128, and optionally to jet pump 136 based upon actuation of shut-off valve 138. Jet pump 128 receives solvent (water) from port 108 through shut-off valve 140. The pressure of solvent provided to jet pump 128 is indicated by pressure indicator 142. As illustrated, solvent in the preferred embodiment is water provided to port 108 at a pressure ranging between approximately 413 kpa to approximately 689 kpa at a rate of 5.7 liters per minute. Preferably, solvent is filtered at y-strainer 144 which provides filtered solvent on lines 146 and 148. The solvent entering jet pump 128 actually causes jet pump 128 to draw sample from the process. The exhaust of jet pump 128 is provided on line 150 and generally consists of a mixture of solvent and sample that flows to gas/liquid separator 152 where gas is separated from the solvent (water or steam). In embodiments where the solvent is steam or water, this process removes particulate and undesirable corrosive water-soluble components, such as SO_2, SO_3, NO_x, HCL, H_2SO_4, CL_2, etc.

Sample is then provided from gas/liquid separator 152 to coalescing filter 154. Coalescing filter 154 is preferably a 0.6 micron filter that further removes additional water or steam. The water or steam so removed by coalescing filter 154 is provided to drain 110 through shut-off valve 156. The sample filtered by coalescing filter 154 is split at node 158 with some flow being provided to vent 120 through flow meter 160, while other flow is provided to air-dryer 162. As illustrated, air-dryer 162 receives dry instrument air, the pressure of which is controlled by pressure regulator 164 (indicated by pressure indicator 166), and the flow rate of which is determined by flow meter 168. Essentially, dry instrument air interacts with the filtered sample stream in dryer 162 to thereby further dry the sample stream. Dry instrument air continues on through dryer 162 and out vent 112. Preferably, dryer 162 is a commercially available, such as those sold by Perma Pure Inc., of Toms River, New Jersey. The sample stream flowing from dryer 162 is split at node 170 with some sample flowing into five-way manual valve 172 and some sample flowing into five-way manual valve 174. When five-way manual valve 172 is suitably actuated, sample flows through flowmeter 176 and guard filter 178 into carbon monoxide detector 180. Carbon monoxide detector 180 provides an output (not shown) that is indicative of the quantity of carbon monoxide flowing therethrough.

In a similar fashion, when five-way manual valve 174 is suitably actuated, sample flows through flowmeter 182, through guard filter 184 and into oxygen detector 186. Oxygen detector 186 provides an output (not shown) that is indicative of quantitative oxygen content in the sample stream.

Those skilled in the art will recognize that while not necessary for practicing embodiments of the present invention, the provision of jet pump 136 reduces sample lag time through the system. In preferred embodiments, this lag time is reduced to less than 10 seconds per 100 feet using a 9.53 millimeter outside diameter sample line. Those skilled in the art will also recognize that by suitably adjusting flow meters 160, 176 and 182 adjustment for sample flow rate and system lag time are provided.

Zero gas is provided through port 114 to five-way manual valve 172 while span gas (CO) is provided through inlet 118 to five-way manual valve 172. In this manner, manual actuation of valve 172 can fluidly couple either zero gas or span gas to detector 180 for calibration and diagnostics. Similarly, zero gas is also provided to five-way valve 174, while span gas (O_2) is provided through inlet 116 to five-way manual valve 174. Thus, actuation of valve 174 can selectively couple zero gas, or span gas to oxygen detector 186 for calibration and/or diagnostics.

It is preferred that materials in contact with the sample be selected to withstand such contact. Suitable materials include stainless steel, polytetrafluoroethylene, polycarbonate, bun-N polypropylene, and polyvinyl chloride. Further still, it is preferred that the sample probe 106 is constructed from an open tube of material such as Hastelloy C alloy available from Haynes International Inc., of Kokomo Indiana, or 316 stainless steel.

Fig. 2 illustrates sample probe 106 configured to obtain a sample from an environment that generally has a number of solids mixed with the sample. Such environments include, but are not limited to, glass furnaces, cement plants, and lime kilns. Probe 106 is passes through stack or duct wall 122 at such an angle θ (theta) which is selected to be between about 120 and 135 degrees. Probe 106 also includes solvent inlet 200, which is coupleable to a source of solvent, preferably water, to allow the solvent to intermix with sample within probe 106 while also cooling probe 106. Due to the angle at which probe 106 is disposed, excess solvent will drain from probe tip 202 along with undesirable solids by virtue of gravity.

Fig. 3 is a more detailed diagrammatic view of probe 106 in accordance with embodiments of the present invention. Probe 106 includes flange 204 for mounting to a process stack or duct wall. Probe 106 includes couplings 206, 208 and 210, for solvent, gas

out, and gas in, respectively. A source of solvent, not shown in Fig. 3, is connected to coupling 206 such that solvent is passed through probe 206 ultimately emerging from spray nozzle 212. Preferably the path of solvent through probe 106 is somewhat circuitous to allow the solvent to cool the probe, which may be exposed to sample temperatures easily ranging from less than 0 degrees Celsius to well over 1000 degrees C. As described above, it is advantageous to mix the incoming sample with a solvent, and nozzle 212 facilitates such function. Coupling 208 is a gas inlet for probe 108 and can be selectively coupled to a source of zero gas or span gas, as desired. Coupling 208 is a gas outlet that provides the sample and mixed solvent to the process instrument for analysis.

Fig. 4 is a diagrammatic view illustrating sample probe 300 in accordance with embodiments of the present invention. Probe 300 preferably consists of a three inch diameter pipe sealed at both distal end 304 and proximal end 306. Probe 300 is mountable to a process, for example via a cement stack wall 308 using a suitable flange 310. The process preferably operates at a relatively low pressure ranging from about 3 psig to about atmospheric pressure (0 psig). Flange 310 is preferably a four inch thick, 150 pound flange. Probe 300 also includes eductor water inlet 312 that is configured to be coupled to a source of eductor water via a 1/4 inch NPT male pipe thread.

Inlet 312 is coupled to eductor 314 by virtue of internal piping 316. Eductor 314 educts solvent, preferably water, that interacts and mixes with the sample flowing within the process and is collected by sample collector 318 which flows through internal piping 320 out sample and solvent outlet 322. Preferably, sample and solvent outlet 322 is configured to have a 1/4 inch NPT male connection.

In order to ensure that probe 300 is maintained at an acceptable temperature, cooling water is connected to probe 300 at cooling water inlet 324. Preferably, cooling water inlet 324 is also a 1/4 inch NPT male connection. Inlet 324 is coupled to the distal end 304 of probe 300 by virtue of internal piping 326. This ensures that the relatively cooler cooling water is provided first to the distal end 304 which then flows back up in the direction of arrow 328 to finally exit probe 300 at cooling water outlet 330. Preferably, cooling water outlet 330 is also adapted to have a 1/4 inch NPT male connection.

Although the present invention has been described with reference to preferred embodiments, workers skilled in the art will recognize that changes may be made in form and detail without departing from the spirit and scope of the invention.